

II. *Part of a Letter from Mr Antony van Leeuwenhoek, F. R. S. dated at Delft in Holland, Sept. 25. 1699. concerning the Circulation and Stagnation of the Blood in Tadpoles.*

IN the beginning of *May* last I saw in a Moat of a friends Country-house, a great many little Tadpoles, that change into Frogs ; and when some learned men of this Country sent me word, that if it did consist with my conveniency, they had a mind to come and give me a visit ; I did agree to it, but was afraid that I should not procure any of these Tadpoles, because it was then late in *June* ; to shew these Gentlemen the circulation of the Blood (which all learned men dive into) and that the more, because these Tadpoles are apt to lye quieter than Eels, and secondly because one may more exactly discern the Arteries from the Veins in them than in any other Animal, and then because even in the smallest or thinnest Veins one may see the red globules of the Blood run further asunder.

These Tadpoles were of several sizes, for the biggest of them were arrived to such a magnitude, that their hindmost Legs began to stick out from their bodies ; the smallest of them were no bigger, than that thirty of them together made but the bigness of one great one : From whence we must conclude, that the Frogs lay their Eggs but very slowly, for then it was already about a month's time agoⁿe that I had made my observations about them, when there was some amongst them that I judged to be half grown.

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The first observation of the motion of the blood that came before me, was a small Vessel, that was a little thicker, than that a red globule of the blood could go through it, which is marked in Fig. 1. with A and B.

This vessel, which is called an Artery, through which the blood coming from the heart from A to B is impelled with great swiftness, divideth itself at B into two branches, which is marked with B C and B E.

These two mentioned branches united themselves again in D, where they remained but for a little space united, as is shewn by D F, and from this vessel did divide again into two branches, F G and F I.

These two branches run crooked, and were united again at H, where they made again somewhat a bigger vessel, as you see by H K, where at K it did unite again into a bigger Vessel.

This being thus, we must call these Blood vessels A B C D F G, and A B E F I Arteries, because they carry the blood from the heart first in G and I: and the blood vessels G H K and I H K we must call veins, because they carry the blood to the heart again.

In another place I saw the blood run in an artery that was so big, that about twenty of these red globules could run together at one time through it.

This was a great artery, in comparison to these here before mentioned, and in this the blood is carried very slowly, a small portion whereof is delineated in Fig. 2. at L M. Out of this blood vessel came a less one, as you may see at M O.

Now had the blood, in the vessel from L to M, not so quick a motion as it had in others, because the blood in the vessel at R did in a manner stagnate, insomuch that one could discern no separated parts in the blood, for it did appear there to be but one even red colour.

Yet

Yet in that blood vessel M O the circulation was so swift, as in any other vessels. I was fully persuaded formerly, that if one doth fall, or is beaten or bruised, that in such a case the blue spots that do appear was nothing else but blood that was stopt, or did stagnate, and that this coagulated blood, before it beginneth to corrupt, was driven out thorough the skin, with the sweat; but by the following observation, I came to be of another opinion.

Now the blood by R being thus without the least motion, it was by every pulsation of the heart impelled upwards from N to P, and in every moment of time, that it was pushed upwards, it came also back again, in such a manner as if we saw before our naked eyes, a very quick motion of a Saw that went backwards and forwards.

So as we know that if we use never so great violence in pressing of water, yet we cannot press it closer together than it was before, the blood now being impelled forwards through the heart, cannot be compressed into a less place.

This being so, we must conclude, that the tunic of the blood vessel between N and P, and also somewhat below N, is distended in wideness by every pulsation of the heart; and as quickly as this uncommon distension is performed, so quickly doth also the tunic of the vessel shrink up again, whereby the blood that was thus pushed forth, is drove and forced to run back again.

Looking upon this attentively, I saw that the blood after a little time, and that the longer the more, from P to R, did begin to come into motion, after such a manner, as to be push'd back again, and I also did judge that the blood vessel marked with M O was during my observation a little more extended, and by

consequence more blood did run thorough it, than when I first began to look upon it.

The blood in the vessel N S, wherein before was little or no motion, did now run as swift as it did in any other vessel.

The blood vessel P Q, which was so small, that but one single particle of the blood could pass through it at once, and wherein at my first view was not the least motion to be discerned, now also begun to flow ; yet the particles of the blood that at first did pass through it, were but a few in number, and consequently far asunder.

Further all the blood, from P to R, was put into a motion, as well by being put forward, as by running back again, and that at each pulsation of the heart.

With these sights I spent, to the best of my judgment, about two minutes ; and being tired with seeing, I rested a little, and being that this little animal in the mean time got into a strong motion, I did stop my further observation.

So that now it doth plainly appear before our eyes, that the stagnated blood, cannot only be made to move again by the motion of the heart, which we call the beating of the pulse, nay, even in such a manner, that the coagulated red globules of the blood are uncongealed again, and assume their first figure. And therefore we have reason to conclude, that the coagulated blood, in any animal, that is coagulated by striking or bruising, and so doth stagnate, can in a few days be made to go or move again, it being allowed of, or taken for granted, that the heart of a man doth push out the blood 75 times in one minute (some say 60 times, but yet I judge the first number to be the nearest) and that is 4500 in an hours time, and 108000 in the space of a day and night.

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Now we finding that in 14 days time the coagulated blood seemeth to be vanished before our eyes, and also considering that in this time the heart doth perform its pulsation 1080000 times, and that in each motion, into several vessels together but the bigness of a corn of Sand has been loosned and set a going, how much may be set a going in the time before mentioned.

I could see in the before-mentioned blood vessel each impulse which the blood received from the heart.

Now if we think or consider that the bigness of a cubic inch of coagulated blood is very much, that is congealed by a blow, and that seldom so much is coagulated at once, then we may very well comprehend, that such coagulated or stagnating blood, through so many motions as we have mentioned here before, may be loosned again, and the motion of the blood may be restored again, if not in all, yet in most of the vessels, as it was before stopping.

At another time I had laid one of these Tadpoles on a clean paper, for a little while before I came to look upon it, whereby a little particle of the Tail came to be wounded, the Skin being dried and stuck to the Paper, so that out of an Artery, which I judged to be so large, that four red globules of the blood could pass thorough it at once, and some Blood did run out of this excoriated part.

This flowing blood did remain quick or without motion about the wounded part; yet this whereon my sight was fixed, that was not half a hairs breadth from the wounded part, or the torn Artery, there came out a little branch of a Vein, wherein the circulation or flowing of that Blood did still remain, as if the Artery had not been broken.

Fig. 3. T U represents the Artery, which is wounded a little above U; U X sheweth the extravasated Blood,

Blood, U W the small Artery, wherein the Blood did retain its full course, although it was so near to the Vein as T U, whereout the Blood did flow, and was extravasated. This seemed to me very strange in the beginning, but when I observed that the Blood-vessel U W was united at W, to a large Blood-vessel that did carry the Blood to the Heart, which we call a Vein, then this Blood out of U W, was carried on with so great a swiftness, and as it was sucked in, just as if it was impelled from T to U; nay, even after such a manner, that I did imagine, that if the Vein at U was not united with T, but had only lain with its opening at U, in the extravasated Blood, that so the extravasated Blood was only for a little while sucked up and carried along.

Then I saw a Vein, wherein the running of the Blood seemed very strange to me; for example: Let Fig. 4. a b be an Artery wherein the Blood is impelled with great swiftness from a to b, then we must call b c, whereby the Blood is carried down, or towards the Heart a Vein: but what name must we give to b e, being that close by it there did lye another Artery, viz. d c e, in which last Vessel the Blood was also carried from the heart, from D to C. Now if the Vein b c be united with the Artery d e; as is seen at C, and thus the Blood is carried from c to e; to be short, we ought justly to call b c, a Vein, and the Blood coming to C, and being there infused in c e, is the arterial Blood, because it is carried there from the heart, it being certain that d c e is an Artery.

Amongst the rest, I have had a Tadpole before my sight, wherein I could not at all perceive any motion of the Blood, how attentively soever I did look on it, whereof at first no reason did appear to me, or what should be the occasion of this stagnation of the Blood; yet when I came to contemplate this Animal with the
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naked eye, I observed that the fore-part of the body of it was squeezed by a narrowness, wherefore I did imagine that the Heart of the Animal was so oppressed, that it could not perform the operation, that doth belong to it, in forcing out the Blood, and receiving it again.

While I was considering of this, the little Animal made a very strong motion, beating his tail about, and bending his body, by which it got its body clear out of the streight wherein it was before ; and when it was thus free and clear, I began to view it again, and immediately I perceived that the Blood began to have a small motion, and impulse again in several Vessels, which did increase from time to time, so that the Blood came quite to its motion, yet not with such a swiftness, as it would have had, if the Body or the Heart had not been hindered.

The motion of the Blood in these Tadpoles exceeds all the rest of small Animals, and Fish, I have seen ; nay, this pleasure has oftentimes been so recreating to me, that I do not believe that all the pleasure of Fountains or Water-works, either natural or made by Art, could have pleased my sight so well, as the view of these Creatures have given me.

Fig. 5, represents the Tadpole of a Frog, that is come to such a bigness, that he could make use of both his legs, and the fore legs of them were also discernible, but yet covered with the skin.

These animals are known by the vulgar sort of people by the name of Thunder-pads, because they imagine that they are derived or procreated from Thunder.

I have often considered, whether the name of Thunder-pads has not been thus derived.

When it thunders and rains, in the time when the Tadpoles are provided with legs, they come in great numbers.

numbers, from out of the ditches, into the roads, or foot paths, to look for their food ; so that many people that easily believe, and never have seen it before, may easily fancy that they did proceed from Thunder: For several years ago a certain person did with great amazement tell me, that when he was passing a certain road, he saw Worms with tails come down with the rain ; and when I did bring him off of his former thoughts by reason, and gave him an account of the procreation of these Animals, he found himself out.

I am not yet wearied with the observation of the circulation of the blood in the said little animals, for every bigness of a Corn of Sand causeth in me new observations ; and now at last I spied a small artery, that notwithstanding it is so small, that, I judge, but one small red globule of blood could pass thro it, yet out of such a branch of a vein still proceeded two other branches, and in each of these branches the blood did flow, yet further asunder, and slower, than they had done before they came into the separated vessels. After these observations, I let my eye run upon the great artery and vein, which was so close to one another, that there was not above the distance of the fourth part of the breadth of the hair of a mans head between them ; and it happening that the Animal, when I was contemplating it, did move its head upwards, and the tail downwards, the blood did run upwards in the artery, and downwards in the vein, and that with an equal velocity ; yet what was most remarkable was, to see the manifold small arteries, that came forth from the great one, and which were spread into several branches, and turning came into one again, and were re-united, that at last they did pour out the blood again into the great vein ; this last was a sight that would amaze any eye, that was greedy of Knowledge.

These Particles of the Blood, are, according to my position, so small, that ten hundred thousand of them cannot make up so great a body as the corn of a great Sand; and from thence we do conjecture, that such small vessels have still branches or channels; for if they were not provided with them, the blood vessels in the thinnest of the tail, where they meet together, should not lye cross one on another, but must be united with one another, which I have not observed.

III. *A relation of the cutting an Ivory Bodkin out of the Bladder of a young Woman in Dublin, by Mr Proby; communicated by Dr Thomas Molyneux, F. R. S.*

D*Orcas Blake*, a full bodied sanguine Maid, of about twenty years old, whilst in her Fathers house, in *Fishamble-street, Dublin*, was much troubled with an hoarseness last winter, for which she was desirous to take a Vomit; but her Friends not consenting to it, she endeavour'd to provoke one, by thrusting her finger into her throat on the fifth of *January, 1694.* which not answering her desires, she drew an Ivory Bodkin of four inches long out of her hair, and thrust the small end forward into her Throat, upon which she heav'd so often as put her out of breath, and oblig'd her to stand upright to draw some air, which she did without taking the Bodkin out of her Throat, and at that instant it slipt out of her fingers, and pass'd into her stomach. The accident put her into some fright, but that soon went off again, because she found no

fig: 5.

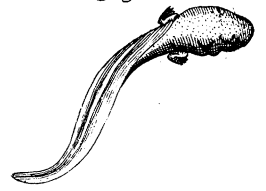


fig: 2.

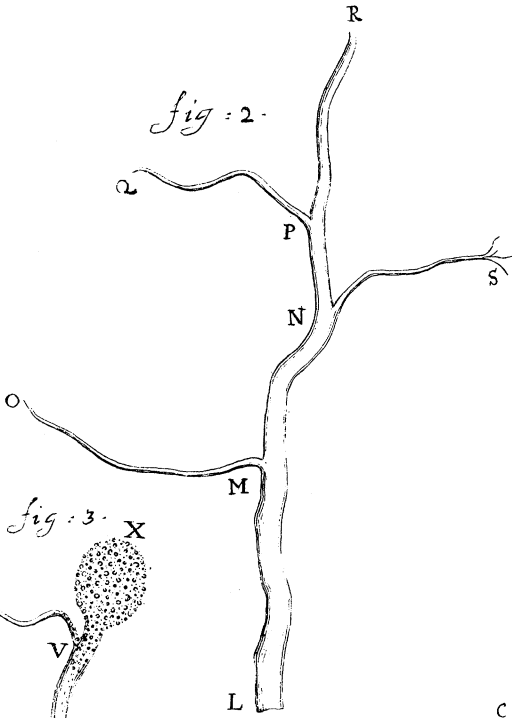


fig: 3.

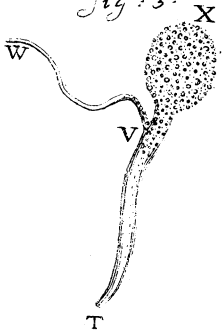


fig: 4.

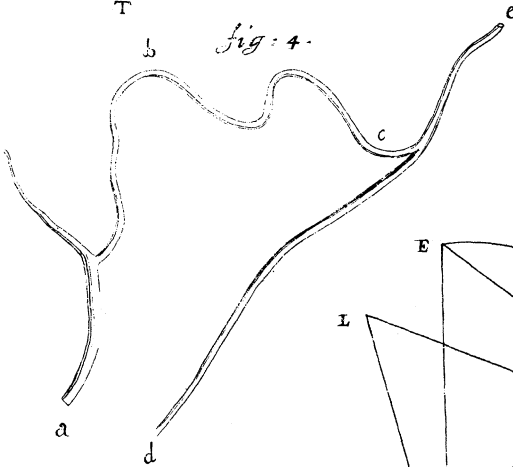


fig: i.

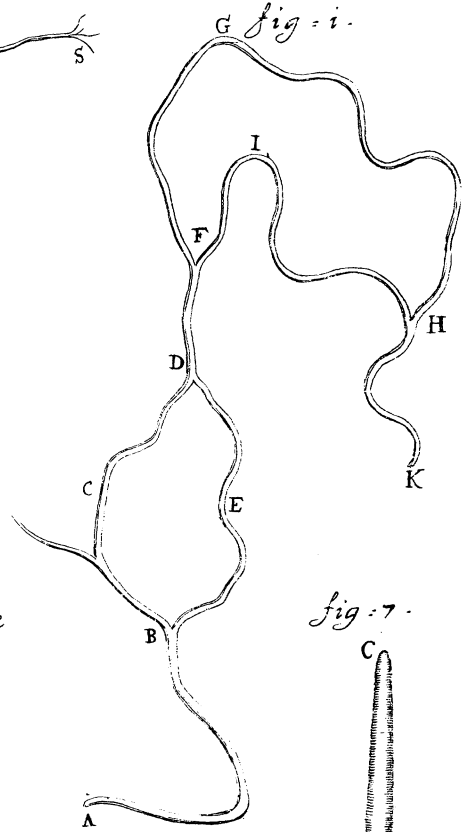


fig: 7.



fig: 6.

